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NASA TECH BRIEF

Solid State Variable Time Delay

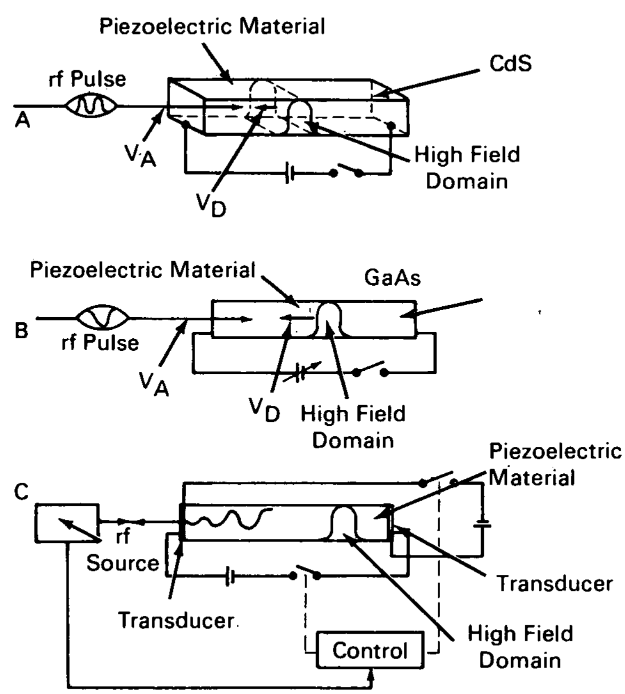

Figure 1. Representations of Pulse Delay Process

This device is designed for use in electronic circuits wherever a fast reacting variable time delay is required, and should prove valuable for application in the communications industry, and to technical personnel involved in the design and development of microwave components and systems. The solid state variable time delay line offers the following advantages: (1) is inexpensive and space saving, eliminating the need for extra equipment to utilize the delay time; (2) does not require mechanically moving components, eliminating vibrations which could prove detrimental in a sensitive environment; (3) does not require the use of a magnetic field to control a time delay; and (4) features the capability for both amplifying and delaying a signal.

Fixed and variable delay lines are widely used in microwave electronic circuits and systems. However, the fixed lines have had the disadvantages of being expensive and limited in scope. Some solid state variable time delay lines have been developed, but they rely primarily on a mechanical means for changing the delay of the delay line. Recently, variable time delays have been designed using the magnetoelastic properties of certain materials such as YIG (yttrium-iron-garnet). The major disadvantage of these materials is that they require a magnetic field, which may be undesirable in specific environments.

Using cadmium sulfide (Figure 1A) as the piezoelectric material, the magnitude of the voltage had no effect on velocity. In Figure 1B, with gallium arsenide as the piezoelectric material (similar materials will serve), the velocity of movement of the high field domain can be varied by controlling the magnitude of the dc voltage creating the high field domain, thus offering an additional method of control.

An electric source is applied across the ends of the crystal (Fig. 1A). A high field domain then propagates from the negative to the positive end of the material (in the V_D direction). A transducer adapted to receive an rf pulse is mounted on the positive end of the piezoelectric material. When an rf pulse is applied to the transducer, an acoustic wave is generated that propagates through the material toward the high field domain (in the V_A direction). The acoustic wave is then reflected because the elastic properties of the high field domain and the bulk of the material differ. The reflected signal

(continued overleaf)

propagates back through the material to the transducer and from the transducer out of the material. The total time delay is the time it takes for the acoustic wave to travel from the transducer to the high field domain and back to the transducer. By varying the point of interaction between the high field domain and the acoustic wave, the total time delay can be varied. The point is controlled by varying the time of creation of the high field domain relative to the time of application of the rf pulse. The variation in application time is determined by the nature of the piezoelectric material. In some devices, the transducer can be eliminated because certain piezoelectric materials form their own transducers.

Figure 1C shows how the acoustic wave is amplified as well as delayed. It also illustrates a means for controlling time of application of various voltages to the body of piezoelectric material, thus providing variable time delay and degree of amplification.

Note:

Requests for further information may be directed to:

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Patent status:

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